A RETROSPECTIVE THREE YEARS OBSERVATIONAL STUDY OF CLINICAL AND ECHOCARDIOGRAPHIC OUTCOME OF PATIENTS WITH SEVERE LEFT VENTRICULAR DYSFUNCTION UNDERGOING AORTIC VALUE REPLACEMENT

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Abstract:

When combined with significant left ventricular (LV) dysfunction, enlarged LV diameters, and low transvalvular gradients, aortic valve replacement (AVR) for either aortic stenosis (AS) or aortic regurgitation (AR) carries a substantial risk of adverse events and poor long-term survival. In individuals with an EF of less than 20%, LV systolic dysfunction is associated with a threefold increased risk of death. However, in adults, the 12-month survival rate is approximately 20% to 50%, making the clinical prognosis significantly worse in the absence of surgical intervention. Assessing the mid-term results of AVR in cases of severe AS, AR, and mixed lesions with significantly compromised left ventricular function was the aim of this study. Pre-formatted templates were used to gather the data, and the data fields were defined in accordance with the American Society of Echocardiography and the Society of Thoracic Surgeons. For the categorical variables, the Chi-square test or Fisher exact test was used to compare preoperative features. For group comparison, all continuous variables were subjected to the Independent t-test or Mann Whitney U test, as applicable.

Patients with severe left ventricular dysfunction benefit greatly from aortic valve replacement, which also lowers left ventricular dimensions and mass, LV mass index, and posterior wall

thickness without raising early or midterm mortality or morbidity. Therefore, a significant decrease in EF shouldn't be interpreted as a reason why AVR isn't appropriate.

Keywords: Aortic valve replacement, Aortic Stenosis, Aortic Regurgitation, Severe left ventricular dysfunction

Main text:

INTRODUCTION

One of the most prevalent cardiac conditions and a major contributor to cardiovascular morbidity and death is valvular heart diseases. In order to diagnose and assess valve disease, echocardiography has become a vital technique. Surgery aims to reduce symptoms, improve outcomes, and prevent aortic complications, postoperative heart failure, and cardiac mortality. According to the American College of Cardiology/American Heart Association and European Society of Cardiology guidelines, aortic valve replacement is a class I indication in patients with severe AS/AR who exhibit symptoms or signs of cardiac dysfunction, which is defined as a left ventricular ejection fraction (LVEF) of 50% or less [9].

In patients with significant left ventricular dysfunction, enlarged left ventricle (LV) diameters [12], and low transvalvular gradients, aortic valve replacement (AVR) for either aortic stenosis (AS) or aortic regurgitation (AR) carries a substantial risk of adverse events and poor long-term survival. Elderly patients who have an EF (ejection fraction) of less than 20% are three times more likely to die from LV systolic dysfunction than those whose EF is greater than 60%. With a 12-month survival rate of about 20% to 50% in adults, the clinical prognosis is even worse in the absence of surgical intervention.

In severe AS, the left ventricle tries to normalize wall stress by hypertrophy in order to compensate for chronic pressure overload. At first, cardiac output and EF are preserved [1]. Due to afterload mismatch, LV systolic function and cardiac output decrease when wall stress exceeds the correcting mechanism [3]. Therefore, aortic valve replacement improves EF symptoms and survival when LV dysfunction is caused by an afterload mismatch, as is the case with severe AS [5].

Early on, compensatory structural alterations in the myocardial are caused by the substantial volume and pressure overload that chronic severe AR places on the LV [15]. Diastolic dysfunction comes before systolic dysfunction in this situation [4]. Eccentric hypertrophy is a hallmark of chamber remodeling that the myocardium experiences in response to volume stress. This indicates that the wall thickness either stays the same or lowers as the heart cavity enlarges. During this phase, patients may experience no symptoms for an extended period of time [7]. The equilibrium between wall thickening and chamber enlargement may be lost as the disease worsens, leading to uncompensated wall stress and a maladaptive reaction [14]. A preclinical stage of LV dysfunction is characterized by a number of molecular, metabolic, mechanical, and hemodynamic reactions [8]. When compensatory mechanisms get overwhelmed, the stroke volume decreases, leading to systolic dysfunction and a marked increase in mortality [10].

One important predictor of the prognosis for individuals receiving AVR for AS/AR is left ventricular dysfunction [11]. Patients with LV dysfunction (EF<30%) commonly face the issue of severely dilated LV preoperatively; LV dilatation may still be present postoperatively. These patients are considered to be at high preoperative risk of death [13].

In addition to valvular unloading, LV mass regression following valve replacement may present a therapeutic target and serve as justification for the identification of supplemental medical therapy that may exacerbate this condition [2]. Additionally, larger early LV mass regression was linked to a trend toward enhanced quality of life at 2 years, which is a significant therapeutic benefit, in addition to hospitalizations.

Methodology:

This is a retrospective observational study of the clinical outcome of aortic valve replacement in severe left ventricular dysfunction.

On fulfillment of inclusion and exclusion criteria, demographic criteria, perioperative criteria, and follow-up data were collected from case sheets compiled in the medical records department. A Performa form has been designed for data collection. Pre-formatted templates were used to gather the data, and the data fields were defined in accordance with the American Society of Echocardiography and the Society of Thoracic Surgeons.

The present study describes a group of patients with AS, AR, and mixed lesion (AS+AR) and reduced left ventricular function who underwent AVR. In order to assess the independent impact of AVR on ventricular function, mortality, and morbidity in severe AS, AR, and mixed lesions, this study does not include patients with CAD, in contrast to the majority of other studies in the literature that do.

FOLLOW-UP:

At three months, one year, and three years, follow-up information was gathered from medical records. NYHA, and echocardiography parameters like Interventricular septal thickness (IVS), posterior wall thickness (PWT), LV mass, LV mass index, Ejection Fraction (EF), LV internal dimension at end-diastole (LVIDd), LV internal dimension at end-systole (LVIDs) are among them [6]. AVR was performed on 74 patients with significant left ventricular dysfunction, and they were monitored for three years.

DATA COLLECTION METHOD:

All patients included in the study were analyzed in a retrospective manner for symptoms and were studied using their case sheets and echocardiography reports.

Echocardiography:

Comprehensive 2D and Doppler echocardiographic assessments were performed. The EF was calculated by the modified Simpson method in M-mode. The LV diameters and wall thicknesses were measured. LV cavity dimension and wall thickness at end-diastole were used to determine left ventricular mass and left ventricular mass indexed to body surface area. Aortic valve

annulus, a gradient across the aortic valve was measured. Echo was done at the time of discharge, 3 months, 1 year, and 3 years.

$$\text{LV Mass}=0.8(1.04((\text{LVEDD}+\text{IVSd}+\text{PWd})^3-\text{LVEDD})^3) +0.6$$

LVEDD - left ventricular end diastolic dimension

IVSd - Interventricular Septal end diastole

PWd – Posterior wall thickness at end- diastole

STATISTICAL ANALYSIS:

SPSS 20.0, the statistical package for social sciences, was used to do the statistical analysis. Various statistical techniques were applied as needed. Nominal data are displayed as numbers and percentages, whereas continuous variables are displayed as Mean ± SD ordinal.For the categorical variables, the Chi-square test or Fisher exact test was used to compare preoperative features. For group comparison, all continuous variables were subjected to the Independent t-test or Mann Whitney U test, as applicable. The Friedman Test or Repeated Measures of ANOVA were used to compare the variables before, during, and after surgery. A p-value of less than 0.05 was deemed significant.

Results:

A total of 74 patients who had severe LV dysfunction underwent AVR. Patients with significantly decreased left ventricular function (EF<35%) were compared before and after surgery. In this study, 18 patients having isolated AS (24.3%),19 patients having isolated AR (23.7%), and 37 patients having mixed lesion of AS +AR (50%) were studied based on inclusion and exclusion criteria and followed up to 3 years.

The baseline patient characteristics are as follow: age 13 ± 83 years, height 142 ± 182 cms, weight 35 ± 96 kgs, BSA (Body surface area) 1.3 ± 2.2 m2, creatinine 0.4 ± 2.9 mg/dl, EUROSCORE II 0.76 ± 17.6, 79.7% male, 20.3% female, 41.9 % presented with NYHA III. 31% patients had diabetes mellitus, 24% hypertensive, 3% chronic kidney disease,11% Chronic Obstructive Pulmonary disease, 11% hypothyroidism. Most common etiology for aortic disease is degenerative (63.5%), rheumatic disease (29.7%), biscupid aortic valve (4%), marfan syndrome (1.3%), infective endocarditis (1.3%).

Preoperatively 47 patients found to have normal sinus rhythm (63.5%), 14 patients (18.9%) have tachycardia, 3 patients (4.1%) have bradycardia, 10 patients (13.6%) have bundle branch block. 29 patients (39.2%) have concentric Left ventricular hypertrophy (LVH), 42 patients (56.8%) have eccentric LVH, 3 patients (4.1%) have normal LVH .24 patients (32.4%) has severe Pulmonary artery hypertension (PAH), 22 patients (29.7%) have moderate PAH, 16 patients (21.6%) have mild PAH,12 patients (16.2%) have no PAH.

All patients underwent Aortic valve replacement, in which 47 had mechanical valves (63%) and 27 had tissue valves (36%). Intraoperatively 42 patients were found to have Bicuspid (59%), 32 patients had tricuspid (41%). Myocardial protection was maintained by hypothermic blood

(83%) and delnido (17%).89% of the operative procedure went without any complications, bypass time was prolonged among four patients (5%), six patients had an episode of Ventricular Tachycardia which was managed with DC shock (8%), one patient went on bypass and supported (1.4%).

Postoperatively 65pateints were in sinus rhythm (88%), 4% had tachycardia, 1.5% bradycardia, 5.4 % had Left bundle branch block, 1.4 % had Right bundle branch block. Mean ventilation hours was 18±7hrs and ICU stay was 4±2 days, hospital stay was 13±7 days.

During three months follow up,16 patients (22%) have concentric LVH, 32 patients (43%) have eccentric LVH, 12 patients (16%) have concentric remodeling,14 patients (19%) have normal LV.68 patients (92%) has no paravalvular leak, 3 patients (4%) have moderate Paravalvular leak, 3 patients (4%) have mild paravalvular leak. 60 patients (81%) have no valvular leak, 2 patients (3%) have moderate valvular leak, 12 patients (16%) have mild valvular leak.

During 1 year follow up, 29 patients (39%) have concentric LVH, 21 patients (28%) have eccentric LVH, 8 patients (11%) have concentric remodeling, 16 patients (22%) have normal LV .72 patients (97%) has no paravalvular leak, 2 patients (3%) have mild paravalvular leak. 58 patients (78%) have no valvular leak, 2 patients (3%) have moderate valvular leak, 14 patients (9%) have mild valvular leak.

During 3 years follow up, 31 patients (42%) have concentric LVH, 12 patients (16%) have eccentric LVH, 8 patients (11%) have concentric remodeling, 21 patients (28%) have normal LV, two patients (3%) expired during follow up due to carcinoma.72 patients (97%) has no paravalvular leak, 2 patients (3%) have mild paravalvular leak. 65 patients (85%) have no valvular leak, one patient (2%) has moderate valvular leak, 8 patients (11%) have mild valvular leak.

Table 1: Comparison of ECHO parameters in isolated AS who underwent AVR

	Preop	3 months	1 year	3 years
LVID(d) in mm	60.44 ± 7.07	50.72 ±9.09*	49.61±11.5*	49.06 ±10.99*
LVID(s) in mm	52.06± 6.16	38.72 ±11.10*	38±12.34*	37.72 ±12.51*
IVS (mm)	12.72± 1.90	10.33± 1.23*	10.22±1.11*	9.67 ±0.97*
PWT (mm)	12.06 ±1.66	10.11±1.23*	10.41±1.08*	9.67 ±1.02*
LV MASS (gms)	334.11± 73.43	194.49 ±52.36*	184.22 ±67.39*	174.44 ±66.91*
LV MASS INDEX(g/m^2)	194.33 ±46.61	118.22 ±30.85*	110.61 ±35.53*	103.83 ±32.56*
EF (%)	28.72 ±2.16	44.94 ±14.82*	51.83 ±14.06*	52.44 ± 13.45*

LVID(d)- LV internal dimension at end-diastole, LVID(s) - LV internal dimension at end-systole, IVS- interventricular septal thickness, PWT - Posterior wall thickness (PWT), EF – ejection fraction, * p value <0.05

Table 2: Comparison of ECHO parameters in isolated AR who underwent AVR

	Preop	3 months	1 year	3 years
LVID(d) in mm	71±11.28	58.47±8.64*	53±6.79*	52.32±7.02*
LVID(s) in mm	60.11±11.02	48.68±9*	42.58±7.76*	40.37±8.30*
IVS (mm)	11.95±2.39	10.37±1.3*	10.32±1.4*	10.16±1.16*
PWT (mm)	11.42±1.8	10.37±1.64*	10.39±1.08*	9.79±1.03*
LV MASS (gms)	413.53±150.06	253.79±76.56*	208.68±37.76*	197.89±53.60*
LV MASS INDEX(g/m^2)	232.74±82.8	143.21±44.84*	117.42±22.06*	111.68±30.17*
EF (%)	29.47±4.6	38.42±8.5*	42.89±8.8*	48.21±9.9*

LVID(d)- LV internal dimension at end-diastole, LVID(s) - LV internal dimension at end-systole, IVS- interventricular septal thickness, PWT - Posterior wall thickness (PWT), EF – ejection fraction, * p value <0.05

Table 3: Comparison of ECHO parameters in mixed lesion (AS + AR) who underwent AVR

	Preop	3 months	1 year	3 years
LVID(d) in mm	58.62±5.8	49.65±6.07*	48.32±5.22*	47.34±4.7*
LVID(s) in mm	49.35±6.87	38.97±6.32*	36.38±5.78*	35.51±7.1*
IVS (mm)	12.22±1.98	10.84±1.59*	10.65±1.54*	10.31±1.15*
PWT (mm)	12.11±1.91	10.62±1.68*	10.44±1.06*	10.14±1.11*
LV MASS (gms)	307.49±82.93	200.46±55.15*	190.08±56*	173.4±38.13*
LV MASS INDEX(g/m^2)	186.51±62.44	122.05±41.57*	115.35±41.09*	104.71±27.77*
EF (%)	28.89±2.5	45.22±8.94*	50.46±8.92*	54.40±8.54*

LVID(d)- LV internal dimension at end-diastole, LVID(s) - LV internal dimension at end-systole, IVS- interventricular septal thickness, PWT - Posterior wall thickness (PWT), EF – ejection fraction, * p value <0.05

DISCUSSION:

Despite the clear recommendation of the ACC/AHA Guidelines to treat patients with severe AS and severe AR with severe LV dysfunction treating this patient population with AVR is generally frowned upon. Surgical procedures were rejected for a variety of reasons, including perceived greater mortality and morbidity, medical comorbidities, and advanced age. Obstacles to AVR appeared to arise not just at the level of the patient but also at the levels of cardiologists, cardiac surgeons, and primary care physicians.

Our study demonstrates that AVR is a reliable indicator of better survival in patients with severe LV dysfunction. The ACC/AHA recommendations to provide AVR to patients with severe LV dysfunction, including those with an EF <20%, are strongly supported by our data.

These patients have a greater improvement in postoperative EF than those who had better preoperative EF, which could explain the relatively low rate of heart failure. Therefore, in cases of severe left ventricular failure, surgery should not be prohibited. The majority can have years of survival and symptomatic improvement, despite the fact that a significantly lower preoperative EF is a predictor of a worse postoperative outcome.

Crucially, our findings demonstrate that atrial fibrillation, advanced age, or significant coronary disease; other valvular heart disease cannot be the cause of the severe LV function decline. A noteworthy finding is that there is a significant increase in LV wall stress with LoEF.

The most significant finding from our data is that most patients continue to be heart failure-free 5 years following AVR. Because of this, even if the patients' preoperative EF was extremely poor, most of them can attain a noteworthy period of event-free survival following correction of Aortic valve pathology. Regardless of preoperative EF, most patients have an improvement in their functional status following surgery. Therefore, we do not believe that a significantly low EF (<35%) is a contraindication to AVR.

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